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THIS PUBLICATION GIVES INFORMATION on new developments of interest to agriculture based on the work done by scientists and agricultural field men of the du Pont Company and its subsidiary companies.

It also gives reports of results obtained with products developed by these companies in the field whether the tests are made by field men of the companies, by agricultural experiment stations or other bodies. Also data on certain work done by agricultural stations on their own account and other matters of interest in the agricultural field.

This issue contains:

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INSECTICIDES AND FUNGICIDES OF THE FUTURE LIKELY TO BE SPECIFICS OF ORGANIC ORIGIN

EDITOR'S NOTE:- The paper given below discusses in a comprehensive manner the present status of insecticides and fungicides and future trends. It is a valuable contribution to a better understanding of means to control pests. It is reprinted here by permission of the author and Dr. Harrison E. Howe, Editor, Industrial and Engineering Chemistry, Washington, D. C.

By R. C. Roark, Insecticide Division,
Bureau of Entomology and Plant Quarantine,
United States Department of Agriculture.

An INSECTICIDE is defined in the Insecticide Act of 1910 as "any substance or mixture of substances intended to be used for preventing, destroying, repelling or mitigating any insects which may infest vegetation, man or other animals or households or be present in any environment whatsoever." A fungicide is similarly defined for use against fungi. Insecticides and fungicides are often confused, and the term "insecticide" is sometimes used to include fungicide, but the one is used to kill insects (animals) and the other to kill fungi (plants). A few materials, such as sulfur dust, have both insecticidal and fungicidal value.

Economic Importance

Economic entomologists estimate that injurious insects destroy annually an average of one-tenth of our growing crops, including forests. In addition, stored grains, flour, seeds, tobacco, dried fruits, nuts, wool, hair, feathers, mohair, clothing, rugs, and fabrics made from animals fibers are subject to insect depredations. Domestic animals and man are attacked by lice, fleas, ticks, mites, flies, gnats, mosquitoes, and other insects which spread diseases and cause death. The total yearly damage caused by insects in the United States has been estimated at $2,000,000,000. Plant pathologists have estimated injury caused by fungi to aggregate $1,000,000,000 annually. The importance of chemical agents for combating these numerous pests is obvious.

The consumption of the principal insecticides and fungicides in the United States during 1934 was estimated to be:

Arsenicals:	
Lead arsenate	40,000,000 pounds
Calcium arsenate	30,000,000 pounds
Paris green	4,000,000 pounds
White arsenic, for grasshopper bait	7,924,000 pounds
Sodium arsenite solution (32% As_2O_3), for grasshopper bait	175,000 gallons

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Sulfur compounds:	
Calcium monosulfide	500,000 pounds
Lime-sulfur (dry basis)	43,000,000 pounds
Sulfur dust	30,000,000 pounds
Oils and organic compounds:	
Kerosene	10,000,000 pounds
Creosote oil, for wood preserving	100,000,000 gallons
Creosote oil, for chinch bug barriers	6,000,000 gallons
Mineral-oil emulsions	40,000,000 pounds
Petroleum oil, for wood preserving	20,000,000 gallons
Naphthalene	16,500,000 pounds
p-Dichlorobenzene	5,000,000 pounds
Plant insecticides:	
Pyrethrum	10,000,000 pounds
Nicotine sulfate (40%)	2,000,000 pounds
Derris	1,000,000 pounds
Cubé	500,000 pounds
Fungicides:	
Copper sulfate	12,000,000 pounds
Zinc chloride	18,000,000 pounds
Sodium fluoride	4,000,000 pounds

This list includes those materials used in largest amounts. In addition, considerable quantities of the following were used: zinc arsenite, magnesium arsenate, manganese arsenate, arsenical cattle dip, sodium arsenite (as a weed killer), copper carbonate, cryolite, ethyl mercuric chloride, pine-tar oil, coal-tar distillates, hydrocyanic acid, carbon disulfide, ethylene dichloride, ethylene oxide, fish-oil and other soaps, etc.

Early Use of Insecticides

Sulfur dioxide, probably the oldest insecticide, was used in ancient times. Arsenious oxide mixed with honey was used as an ant poison in the seventeenth century, and tobacco was used against plant lice in 1690. During the nineteenth century a wide variety of plant and mineral products were proposed as insecticides. Whale-oil soap came into use for pest control in 1842, pyrethrum about 1860, kerosene in 1865, Paris green before 1870, Bordeaux mixture in 1883, and lead arsenate in 1893.

The commercial manufacture of these materials (except Paris green) did not assume large proportions until early in the twentieth century. In 1908 Luther and Volck obtained a patent on the production of lead arsenate from litharge and arsenic acid. This process enabled the product to be made at low cost and greatly stimulated its use. In recent years the consumption of all insecticides and fungicides has markedly increased, owing to the spread of old pests over large areas and to the invasion of the country by new pests. For example, calcium arsenate was first used in dusting cotton plants to

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protect them against the boll weevil about 1915, and less than twenty years later the yearly consumption was 30,000,000 pounds. The use of mineral-oil emulsions against citrus and deciduous fruit tree pests has grown rapidly in recent years, owing to the development of oils that could be used without seriously injuring the host plants. This development was due directly to research showing that unsaturated hydrocarbons are highly toxic to plants and that an oil low in sulfonatable constituents must be used if injury is to be avoided.

Future Trends

At present inorganic insecticides, especially arsenicals, dominate the market. In the future we shall see arsenic, lead, fluorine, mercury, thallium, boron, selenium, and other inorganic materials largely replaced by organic products.

The principal reason for this is that the public is becoming increasingly conscious of the menace to health resulting from the presence of spray residues of lead arsenate, cryolite, etc., on fruits and vegetables and is beginning to demand foodstuffs free from these poisons. Pure food and public health officials have ruled against the marketing of fruits and vegetables bearing excessive quantities of arsenic, lead, or fluorine. The United States Department of Agriculture has established the following tolerances for spray residues on fruit for the crop season of 1935: lead, 0.018 grain Pb per pound (equivalent to 2.5 p. p. m.); arsenic, 0.01 grain As_2O_3 per pound (equivalent to 1.4 p. p. m.); and fluorine, 0.01 grain F per pound. In order to meet these tolerances, it is necessary to wash apples carefully in a chemical washing solution. Usually a one per cent solution of hydrochloric acid is employed. This operation may add as much as 5 cents a bushel to the cost of the apples. This washing cost could be greatly reduced if a substitute for lead arsenate were known which left no toxic residue on sprayed fruit. The prospects of finding insecticides of low toxicity to man are much better in the organic than in the inorganic field.

Organic compounds of possible insecticidal value may be sought among animal and vegetable products or may be synthesized from their elements or from other organic substances obtained from natural gas, coal tar, petroleum, shale oil, or elsewhere. Although soaps made from fish oils, whale oils, or other animal oils and fats are useful in killing insects, soaps made from vegetable oils are in general of equal value. Other animal products, such as glue and gelatin, are useful as emulsifiers, stickers, and spreaders combined with standard insecticides, but of themselves possess little insecticidal value. In general, therefore, animal products do not appear to be promising sources of insecticides.

Insecticides Derived from Plants

On the other hand, vegetable products offer great possibilities for use as insecticides either directly or as the starting point for the preparation of synthetic compounds. Many of our most potent and widely used insecticides are derived from plants such as tobacco,

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pyrethrum, derris, cubé, hellebore, larkspur, quassia, red cedar, and numerous plants from which essential oils are obtained. Geraniol is useful in attracting Japanese beetles into traps, and methyl cinnamate has shown promise as an attractant for the oriental fruit moth. Petroleum hydrocarbons, derived from plants of earlier geological times, are employed extensively in the form of aqueous emulsions for spraying trees, and several million gallons of refined kerosene are employed in the manufacture of household fly sprays. Of the thousands of known plants only a few have been carefully tested for their insecticidal value. Many of the insecticides of the future will undoubtedly be derived from plants. The finding of rotenone in the devil's-shoestring (Cracca virginiana L.) calls attention to the possibilities of finding valuable insecticides in the commonest weeds.

The extreme potency of some of these plant insecticides is illustrated in the case of rotenone. This compound is a colorless, odorless, crystalline material which melts at 163°C. (325.4°F.) and has the formula $C_{23}H_{22}O_6$. It is insoluble in water but soluble in chloroform, benzene, acetone, and certain other organic solvents. Rotenone is thirty times as toxic as lead arsenate when fed to silkworms, fifteen times as toxic as nicotine when sprayed on bean aphids, and twenty-five times as toxic as potassium cyanide to goldfish. On the other hand, its toxicity to mammals when taken by mouth is vastly less than that of these materials. The acute toxic dose of rotenone to dogs is greater than 7 grains per pound (1000 mg. per kg.) of body weight. The chief value of rotenone is due to this differential action in its toxicity -- that is, to the fact that it is highly toxic to lower forms of life, such as insects, but is relatively nontoxic to the higher forms of life, especially mammals. The chances of finding other substances with these characteristics are much better among organic compounds than among inorganic materials.

Synthetic Organic Insecticides

At present only a few synthetic organic compounds or organic compounds derived from natural products by distillation or other simple treatment are used as insecticides. Naphthalene is a valuable fumigant, especially for certain types of soil insects and greenhouse insects. p-Dichlorobenzene is used on a large scale in combating the peach borer. Recently certain aliphatic thiocyanates have been put on the market for use both in fly sprays and as contact insecticides against the red spider, mealy bugs, and other pests. These thiocyanates appear highly toxic to some insects.

The number of synthetic organic compounds that is possible to make it practically limitless, but only a small percentage of these can be expected to have appreciable insecticidal value. If the radicals in organic compounds that are responsible for toxicity to insects were known, the task of synthesizing the ideal insecticide would be greatly simplified. As yet, however, little is known concerning toxophoric groups in organic insecticides. Many investigators have carried on researches with heterocyclic compounds containing

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nitrogen, especially derivatives of pyridine and pyrrolidine, in an effort to find a compound structurally related to nicotine which might possess insecticidal value. The great amount of work that has been done in this direction has given us only one product of high insecticidal value - namely, anabasine. This alkaloid, found in the Russian weed Anabasis aphylla, was synthesized by C. R. Smith, of the Insecticide Division, from bipyridine and called by him "neonicotine". Anabasine is even more toxic than nicotine to aphids, but it is not so effective against other insects. It is one of the few complex organic compounds that have been synthesized which possess insecticidal value, and the natural anabasine obtained from the plant is much cheaper than the synthetic product.

Pessimists point out that few products of nature have been synthesized on a commercial scale. Nicotine has been synthesized in the laboratory, but only at prohibitive cost. Rotenone and the pyrethrins are too complicated in structure to permit of their synthesis in the light of our present knowledge of organic chemistry. There is, however, no reason why an organic compound must have a highly complex structure in order to possess insecticidal value. The esters of formic acid and of monochloroacetic acid are among the simplest organic compounds, yet in the vapor phase they are very toxic to insect life. Ethylene oxide, perhaps the simplest of the heterocyclic compounds, is exceedingly toxic to insects and is now used on a large scale in admixture with carbon dioxide for the destruction of insect pests in a great variety of food products. Recent work in the Department of Agriculture has shown that certain easily prepared heterocyclic compounds containing sulfur in the ring are exceedingly toxic to some insects. Organic sulfur compounds are probably the most promising sources of new insecticides.

Need for Pharmacological Research

The search for materials that are toxic to insects, on the one hand, and relatively nontoxic to man and domestic animals, on the other, is handicapped by our lack of knowledge of the pharmacological and toxicological action of most organic products. Nothing is known concerning the possible poisonousness of whole series of organic compounds. It is necessary that much pharmacological work be done before progress can be made in the development of new organic insecticides. Not only must the acute toxic effect of these materials be determined, but public health officials are now interested in the cumulative effect of long-continued ingestion of small quantities of various materials that may be left upon fruits and vegetables in the form of spray residues.

A not inconsiderable advantage that organic insecticides have over inorganic is their instability when exposed to light and air in thin films such as those formed by spray residues. Many organic compounds, such as nicotine, rotenone, and the pyrethrins, lose their toxicity under outdoor conditions. While this loss in toxicity detracts from their insecticidal value, it also reduces to a negligible quantity the health hazard of the spray residue to the consumer.

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Attention should be called to the specificity of organic insecticides. A compound that is deadly to one insect may be harmless to another. This means that a veritable pharmacopeia of products must be available if man is to wage war successfully upon a million species of insects. Organic chemists need not fear the exhaustion of this field of research by the discovery of a few potent products.

Fungicides

Little has been said about fungicides, which, broadly interpreted, include bactericides. Copper, mercury, zinc, and sulfur have remained almost the only fungicides in general use for half a century. Organic compounds of mercury have come into use as seed disinfectants, but their high toxicity to man restricts their usefulness. Cannot compounds wholly organic in nature be developed to replace the inorganic fungicides? The high bactericidal efficacy of various alkyl phenols illustrates the possibilities in such an undertaking.

NEW DISCOVERIES IN RELATION TO SEED TREATMENT WHICH FURTHER EMPHASIZE THE NEED FOR TREATING

EDITOR'S NOTE:- This is probably the most enlightening article on seed treatment which has come to our attention. It would seem that certain of the facts developed by Mr. Miles well could point the way to research along new lines in relation to seed treatment.

By G. F. Miles, Research Department,
Bayer-Semesan Company, Wilmington, Del.

Ask 100 grain growers why they treat their seed grains and 99 will respond that the purpose of seed treatment is to control smut. That reply is true and correct as far as it goes, and, until recently it told practically the whole story. During the past few years, however, investigations looking toward improvements in the practice of treating seed grains have uncovered new principles and new disinfectants which furnish important additional reasons for disinfecting seed grains. The most recent introduction of this sort is the new ethyl mercury phosphate dust.*

In developing this product, it was necessary to be sure not only that it provided good control of the smut diseases, but also that it did not injure the seed and depress the yield. To obtain this information, numerous yield tests were conducted by official and unofficial workers. These tests covered a number of the important grain growing states and included, in addition to the new mercury compound, some of the more commonly used older disinfectants such as copper dusts and formaldehyde.

Treatment Increased Yields

These field investigations showed that the mercury compound under ordinary conditions of use did not reduce yields. In fact in a large percentage of cases it actually increased yields 5 to 20%. Such increases in yield naturally are to be expected when smut is present in the untreated crop. Thus, if a given lot of seed produces a crop showing 5% smut, any effective grain treatment should control the smut and increase the yield to that extent. It was soon found, however, that increases in yield often resulted from seed treatment in the absence of smut as a factor. This was particularly true of ethyl mercury phosphate and to a less extent of some of the other disinfectants.

For example, in 1933, tests with twelve different lots of oats in Illinois, North Dakota and Minnesota showed that treatment with ethyl mercury phosphate increased the yield more than ten per cent.

In that same year 14 tests with spring wheat showed the mercury treated seed outyielding the untreated seed by nearly 5%. In none

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of these oats and wheat tests did the crop from the untreated seed show more than a fraction of a per cent smut. Increases in yield for the treated seed apparently must have resulted from causes other than the control of smut.

Again, in 1934, forty-seven tests on oats in Kansas, Illinois, Nebraska, North Dakota and Minnesota showed that treatment of the seed with ethyl mercury phosphate increased the yield nearly 21%. The average per cent of smut in these tests was 7.4. Obviously part of the increase in yield was due to some cause other than smut control.

Nine winter wheat tests in Kansas and Georgia harvested in 1934 showed an average increase in yield of 8.5% as a result of seed treatment. In no case was there more than a mere trace of smut in the untreated portions of the test.

Fifteen spring wheat tests in Minnesota and North Dakota in the same year showed an average increase in yield of 5%. Again the increase in yield cannot be explained on the grounds of smut control, for in the entire fifteen tests not one single smutted head could be found in either the treated or the untreated portions.

Reasons for Better Yields

These rather striking benefits resulting from treatment of the seed with ethyl mercury phosphate dust naturally call for an explanation. Organic mercuries, such as ethyl mercury phosphate, have been credited sometimes with stimulating plant growth. Those closest to the problem, however, have never seen convincing evidence that any compound of this type actually stimulates increased growth of the plant.

A more logical explanation, it seems to them, is to be found in the fact that grain seeds and soils often carry at least several different parasitic organisms in addition to the smuts. It is quite certain that these organisms, for the most part fungi (molds), are responsible for infections or attacks on the germinating seed and seedling. Some of these organisms are well known in the scientific world but little known among grain growers. Attacks by them result in the rotting or decay of the seed, seedling blights, and root rots of the seedling. That these organisms, other than smut, may have a depressing effect on yield and that seed treatment will prevent this damage can be demonstrated at least partially in the laboratory.

If treated and untreated portions of a grain sample are germinated under suitable conditions of moisture and temperature in the laboratory, it will be observed frequently that the untreated seeds and seedlings are overrun with one or more kinds of fungi (molds). Ordinarily, the treated sample of seed remains quite free from molds. If the seedlings from treated and untreated seeds are measured carefully, it will be found in a majority of cases that the rate of growth of the treated lots has been from 5 to 20% greater than for the untreated lots. This would seem to be fairly conclusive evidence that the molds retard the rate of growth of seedlings grown from untreated seed. The application of a suitable disinfectant

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prevents infections or attacks by the molds and permits the seedling to grow normally. This protection of the seed and young seedling probably accounts for the improvement in seedling growth in the laboratory and for the increases in yield secured in field tests.

Thus, the disinfection of seed grains takes on a somewhat new aspect. While formerly we disinfected seed primarily to control smut, we are beginning to realize that for the average grower the benefits to be obtained from seed disinfection in the way of larger yields may be of greater importance than those to be derived from smut control. In the future, progressive grain growers will disinfect their seed grain annually to improve stands and yields by reducing seed decay, seedling blights and root rots. Smut control no longer will be the primary purpose of seed treatment, although it will continue, of course, to be an important reason for seed treatment.

More Interest in Treatment

This broader aspect of the purposes of seed treatment may be expected to have a direct bearing on the efforts of the agricultural extension service to reduce our present large annual loss from smut. Arguments for seed treatment will be strengthened greatly; and it should be easier to convince grain growers of the value of the practice. There has been a very human tendency on the part of grain growers to take a chance on smut. This willingness to gamble with smut by treating only once every few years, or not at all, has been fostered by the belief that the only benefit from seed treatment was the control of smut.

As grain growers come to realize, however, that disinfection of the seed is a means of securing better stands and yields, we can expect seed treatment to take its place as an annual practice on many more farms and to see a correspondingly heavy cut in our smut losses.

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* "New Improved Ceresan".

ZINC TREATMENT OF PECAN ROSETTE IN ARIZONA SHOWS RESULTS THAT ENCOURAGE EXPERIMENTERS

EDITOR'S NOTE:- Below are printed excerpts from Extension Circular No. 82, "Zinc Treatment of Pecan Rosette", published by the University of Arizona, Tucson, Arizona. The authors are Dr. A. H. Finch, Assistant Horticulturist, and Mr. A. F. Kinnison, Horticulturist, Agricultural Extension Service. It is recommended that any one interested in the control of pecan rosette obtain a complete copy of this valuable circular. It is regretted that space does not permit its reprinting in entirety here.

Pecan trees in some districts of Arizona are commonly affected by a disease known as rosette. The first symptoms of this are usually a slight yellowing or chlorosis of the newer top-most leaves. Affected leaves and leaflets generally remain small, develop prominent veins, are frequently misshapen, crinkled and brittle. Later in the summer, leaves so affected may turn brown or "burn" and fall from the tree. The new top-most shoots may die and in some cases the older wood is also included. Below this, relatively healthy growth often arises giving a cluster or "rosette" of branches which later become affected. Because of the various symptoms displayed by diseased trees, the disease is commonly referred to also as "burning," "die-back," and "frizzles."

Pecan rosette was one of the first serious troubles to develop with the commercial planting of pecans in the South. It was recognized as early as 1900 and according to Demaree investigations were initiated in 1902 by the United States Department of Agriculture workers in southern Georgia. The disease occurs throughout the older pecan districts from Texas to the Atlantic coast. In Arizona rosette seems to have been first reported from Sacaton in 1911, indicating that it has been present here for more than twenty years. Because of it, pecan plantings have been abandoned in the Santa Cruz, Casa Grande and other valleys of southern Arizona and pecan culture has been discouraged in the Safford and Salt River Valleys. In the Gila Valley from Florence to the Colorado River, rosette has been especially severe. Trees in the Yuma Valley have generally been free of rosette although some, particularly along the eastern side of the valley, have been rather severely affected. Rosette occurs in some plantings in California and New Mexico.

Studies of pecan rosette were initiated by the Arizona Experiment Station in the fall of 1931. From these, it was learned that the disease yielded to treatment with zinc. This was indicated in the annual report of the Arizona Agricultural Experiment Station for the year ending June 30, 1932, pp. 96-97, and discussed more completely in subsequent papers. (1,2). Similar findings were reported more or less simultaneously by Alben et al (3,4) in Louisiana,

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and Demaree (5) in Georgia. That a similar disease of other fruit trees might be susceptible to treatment with zinc was reported by California workers in December of 1931. (6) This paper was published in the early spring of 1932 but did not come to our attention until September of that year (correspondence with W. H. Chandler, Sept. 2, 1932).

The various data suggest that pecan rosette is a zinc deficiency disease - that the tree rosettes because there is not sufficient zinc available for its healthy growth. Such an interpretation of the role of zinc is not yet beyond question, but furnishes a satisfactory working hypothesis.

There are two ways in which a zinc deficiency may be brought about, (1) by an insufficient amount of zinc in the soil and irrigation water and, (2) by conditions which make zinc, though present in the soil or irrigation water, unavailable to the tree, especially to the top-most parts. It is not known whether the occurrence of rosette in Arizona is because of a complete absence of zinc, or of a lack of its availability in the soil or growing parts of the tree. Supplying soluble zinc is probably an effective treatment in either case for it has consistently brought about improvement of affected trees. If zinc is present but unavailable in Arizona soils, then cultural methods making it available may in time be worked out. Zinc occurrence and factors governing its availability constitute an important and necessary field of investigation.

Zinc may be applied to pecan trees in three ways: (1) application of a soluble salt to the soil or irrigation water, (2) placing the dry chemical in holes bored into the tree trunk, or injection of a zinc solution into the trunk, and (3) spraying the foliage with a zinc solution. For all of these the most satisfactory form to use is the commercial zinc sulfate, a white flaky material soluble in water. This form, having the formula $ZnSO_4 \cdot 5H_2O$, has given good results. Other forms having more or less water of crystallization are available and should give equally satisfactory results.

(1) Finch, A. H. Pecan rosette, a physiological disease apparently susceptible to treatment with zinc. Proc. Amer. Soc. for Hort. Sci. 29:264-66. 1932.
(2) Finch, A. H. and Kinnison, A. F. Pecan rosette: soil, chemical and physiological studies. Ariz. Agr. Exp. Sta. Tech. Bul. No. 47. 1933.
(3) Alben, A. O., Cole, F. R., and Lewis, R. D. New developments in treating pecan rosette. Proc. Nat'l. Pecan Asso. 1932.
(4) Alben, A. O., Cole, F. R., and Lewis, R. D. New developments in treating pecan rosette with chemicals. Phytopathology 22:979-81. 1932.
(5) Demaree, J. B. Progress of pecan rosette control. Proc. Georgia-Florida Pecan Growers Asso. 27:38-45. 1933.
(6) Chandler, W. H. Hoagland, D. R., and Hibbard, P. S. Little leaf or rosette in fruit trees. Proc. Amer. Soc. for Hort. Sci. 28:556-60. 1931.

RESEARCH AND EXPERIMENTS IN PEST CONTROL BEING CARRIED ON IN PACIFIC COAST STATES

EDITOR'S NOTE:- The work described below is being conducted by the Pest Control Section of the Grasselli Chemical Company, Cleveland, Ohio. Dr. W. H. Tisdale is the head of the Section. The results of the investigations will be reported later.

The Grasselli Chemical Company is conducting extensive investigations in California and Washington State in an effort to develop a better and less poisonous or non-poisonous stomach insecticide for the control of the codling moth and other economically important insects.

The Company has leased an orchard in the famous apple growing region at Wenatchee, Washington, in which an intensive study is being made of the codling moth problems, especially relative to the chemical control of this serious pest. Some of the insecticides being investigated are Dutox, Manganar, Kutane, Loro and some new and attractive organic compounds, some of which are proving considerably more toxic to the codling moth than arsenate of lead, with which these compounds are being compared.

In addition to the study of insecticides, assistants or spreading and sticking agents to be used with the insecticides are being investigated. Some attractive new compounds have been developed and field evaluation is now under way. At harvest time consideration will be given to better methods of washing for removal of poisonous residues. Some new chemicals will be tested in these residue removal experiments. The Company also is investigating the usefulness of these stomach insecticides for the control of chewing insects on various other fruit, vegetable, and ornamental crops.

Experiments with Loro

"Loro," a new Grasselli contact insecticide, has proved outstanding in effectiveness for the control of some of the insects of citrous, including aphids, red spider, mites, and black scale. It has proved more effective than compounds previously used for this purpose. The use of the product on citrous is increasing very rapidly due to its effectiveness. Investigations are still under way, however, for further improvements along the lines of modifications and methods of application of the product for the control of citrous insects. This work is being done in cooperation with the Pacific Division R. & H. Chemicals Department, E. I. du Pont de Nemours and Co.

"Loro" also is being investigated for the control of sucking insects on various other crops throughout the Pacific Coast regions. In addition to the cooperative investigations under way with the Pacific

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Division, R. & H. Chemicals Department, Grasselli has two field research men investigating Loro for the control of insects of prunes, grapes, and other fruit crops; elms, peas, and various other vegetable crops; flowers and ornamentals. These men are located in Berkeley and San Jose. Results of investigations to date indicate that many uses will be found for this new insecticide.

TESTS OF FLUOSILICATES IN WAREHOUSE SANITATION GIVE EVIDENCE OF VALUE FOR THE CONTROL OF PESTS

EDITOR'S NOTE:- The results of tests, described below, suggest possibilities which would seem to warrant further investigation of the place of the fluosilicates in rodent and insect control in buildings.

By F. T. Evans, Horticulturist,
Pest Control Section,
The Grasselli Chemical Company,
Cleveland, Ohio.

The grain trade and warehouse men in certain areas have been giving close attention for a number of years to granary and warehouse sanitation, particularly with regard to the control of insects and roaches in warehouses adapted to the storage of sacked grain.

State entomological authorities in these areas have been studying these problems in an endeavor to improve control materials and methods for use on these destructive pests. The fluosilicates have been used by a number of experimenters as a control in warehouse sanitation experiments. The following extract from Volume 22, No. 12, Monthly Bulletin of the State of California, Department of Agriculture, is illustrative of this problem as it occurs in sack grain storage in California.

"The Entomological Service, in cooperation with the Division of Field Crops, has been slowly testing the efficacy of various insecticides offered for sale, to enable the Department to recommend dosage formulas and schedules which will permit successful treatment where this consideration is alternate to removal of the grain. Tests with gaseous insecticides include hydrocyanic acid and chloropicrin, also a 50-50 per cent mixture of the latter with carbon tetrachloride.

"In our efforts to develop better warehouse sanitation, work has continued with sodium fluosilicate to prevent the movement of weevil from infested to uninfested grain. One of the unlooked-for results in the use of this compound has been its very effective control of rats and mice. To check its utility, this type of control has now been under observation through its second year, and the damage which formerly necessitated resacking 3000 bags of grain was reduced to less than 300 bags the first year. In the second year, practically no resacking was necessary.

"One warehouse under observation, indicates a very marked reduction in damage traceable to rodents. Tests made in cooperation with the office of rodent control have shown that the poison is taken up on the feet. Due to irritation, the

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rodents lick it off and assimilate enough poison to produce death. In cage tests, mice assimilated enough to cause death in 4 to 5 days. While tests on rats are more limited, in cage tests they died in three days.

"In a dwelling house where rats had been numerous in the unfinished attic, the floor was dusted once, and a week later the trouble ceased. During that period, three dead adult rats were found in the yard close to the house. While this is not conclusive evidence that they were killed in the house, the fact that they did not recur points at least to repellent action.

"Tests with this compound have been continued in an effort to control such secondary pests as sawtooth grain beetle and flour beetles which at first did not seem to react in the same degree as granary weevil.

"Observations of dusting under industrial conditions reveal that sodium fluosilicate exerts considerable action on these short snouted beetles, though the effects are not noticeable for thirty to sixty days from date of application. For general dusting of warehouses, this material has been used at the rate of one pound of the fluosilicate to ten tons of sacked grain."

Barium Adds to Effectiveness

Barium fluosilicate*, one of the newer fluosilicates, and now available as an agricultural insecticide, when dusted in the commercial form has proved to be the most effective practical control for a number of important beetles and weevils. The fact that this material contains barium might possibly make it even more effective than the sodium compound as a rodent control.

Barium fluosilicate, has been used in a number of practical trials insofar as rodent control is concerned and it has been found highly effective. This fluorine compound has also been used in a number of practical situations where beetles have attacked record books, wall papers, etc. Light applications of the commercial form of barium fluosilicate as a dust according to reports is practically a complete control.

In household applications or other situations where the human element enters into the problem it must be borne in mind that barium fluosilicate is a poisonous fluorine compound and that proper precautions must be taken at all times in handling or distributing the material in dwellings.

*"Dutox"

THE USE OF EXPLOSIVES IN GULLY BANK BLASTING TO CONTROL EROSION AND PROTECT ADJACENT LAND

EDITOR'S NOTE:- Although the blasting of gully banks is a comparatively new practice, it has come into wide use because of its efficiency and economy. The recommendations made here by Mr. Livingston represent the results of careful study and many experiments.

By L. F. Livingston, Manager,
Agricultural Extension Section,
E. I. du Pont de Nemours & Co.

Not until the introduction of the use of explosives for the purpose was there a means of controlling gullies which was practical for large scale operations. But even so, the methods first used had a drawback, in that they were not economical. The reason was that too much blasting was done, with consequent waste of explosives.

In these first experiments, the plan was to give quite a slope to the gully banks. This, with the thought of planting on the slopes, as well as in the bottom of the gully. It was discovered however, that the greater benefit obtained was from the depositing of a sufficient quantity of topsoil in the gully bottom to make possible the growth of planted trees, bushes and grass. As a result, there was adopted the practice of doing just enough blasting to provide a bed of topsoil of required width and depth.

The Need For Soil-saving Dams

But before discussing blasting methods, it should be pointed out that the soil thrown down by blasting, to be of any value at all, must be kept from washing away during periods of rainfall. It, therefore, is necessary to construct soil-saving dams at carefully selected points in the bottom of the gully.

These dams may be temporary ones or those of a permanent type. However, since expense is a factor, it is usual to depend upon temporary dams.

Permanent dams are, of course, more satisfactory in many cases. Under certain conditions they are necessary. A thing to be taken into consideration when deciding between permanent and temporary types of dams is the value of the farm land to be protected. Where it might not pay to go to the expense of permanent dams, because of the low value of the land, there is nothing left to do but depend upon temporary ones. On the other hand, land with a high value may warrant the cost of permanent dams. Fortunately, in many instances, if not in the majority of cases, temporary dams, properly constructed, are sufficient.

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Explosives for Gully Bank Blasting

Of primary importance is the kind of explosive. Neither black powder nor stick dynamite gives wholly satisfactory results, although dynamite in stick form was the explosive used for much of the earlier work.

The best type of explosive for gully bank blasting is free-running powder. It really is a granular form of dynamite. This powder, experience shows, breaks down the earth properly and more or less pulverizes it. The advantage is obvious, since plantings can more readily take root in soil which is well broken up.

Free-running powder is put up in 12 1/2-pound bags and packed in 50-pound cases, the same as dynamite. A pint of it equals one pound, thus making it easy to use the proper amount of the explosive when loading.

For priming, a half stick or a stick of dynamite with an electric blasting cap is used in each hole loaded with free-running powder. The reason for this is because it is not practicable to prime a loose form of explosive, such as free-running powder, with a blasting cap. Priming is done with a 20 per cent ammonia dynamite or it may be done with a gelatin or a straight nitroglycerin type.

Number 6 electric blasting caps, with 8- or 10-foot leading wires, are recommended for gully bank blasting. These caps are packed 50 to a carton, in wooden cases containing 500, 2000 or 5000 caps.

The equipment of tools and blasting accessories for this type of work has been standardized in a measure. While the list is omitted here, it is to mention the fact that the most important tool is the 3-inch post-hole or soil auger which is used for putting down the holes.

Loading Plans and Loadings

Minimum Loading: The holes are put down in a single row on 6-foot spacings at a distance of 2 1/2 feet from the face of the gully. These holes are 3 1/2 feet deep. Each hole is loaded with 1.5 pounds of explosives. This loading is for gullies 6 to 8 feet deep.

Medium Loading: Two rows of staggered holes are made. All the holes are spaced 8 feet apart. The front row of holes are 4 feet deep and are put down at a distance of 3 feet from the face of the gully. The rear holes are 3 feet deep and are located 5 feet from the face. Two pounds of explosives are loaded to each of the front holes, and 1.25 pounds to each rear hole. Gullies 8 to 12 feet in depth are loaded as described.

Maximum Loading: Staggered holes in two rows on 8-foot spacings are put down. The front and rear rows are 3 and 5 feet, respectively, from the face. The depth of the front holes is 5 feet,

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while that of the rear holes is 3 1/2 feet. Each of the front holes is loaded with 3.5 pounds of explosives, and 2 pounds are used for each rear hole. This is the loading for gullies 15 to 20 feet deep.

These recommendations for loading are based on the use of one-half pound or one stick of 20 per cent nitroglycerin dynamite or 20 per cent ammonia dynamite per hole as a priming charge, and the specified quantity of Red Cross Free-running Powder No. 2.

Method of Firing and Safety Rules

The electric blasting caps in all the holes of a section of gully bank to be blasted are wired in series. Shooting is done with an electric blasting machine. The use of fuse for this type of blasting is not recommended.

To avoid possibility of an accident, all the men engaged in gully bank blasting should be thoroughly instructed in safety practices and should be required to observe them strictly. Also, it is very essential that those in charge of operations be competent in handling explosives and be familiar with blasting methods.

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